1. A gas correlation camera comprising:

   (a) at least three gas correlation cells, one of said cells filled with a first gas capable of absorbing infrared radiation at one infrared band, and another of said cells filled with a second gas capable of absorbing infrared radiation at another infrared band, and a third of said cells that does not absorb infrared radiation; and

   (b) a camera with imaging optics and 2-D array detector for determining the spatial distributions of both the spectral and energy content of said first infrared band and the spectral and energy content of said second infrared band and using the third cell as a null (non-absorbing) energy content reference.

2. The gas correlation camera of claim 1 wherein said at least three cells are retained in proximity on a cell retaining plate and said plate is linked to a source of motive power that moves said plate so that said at least three cells are moved separately sequentially into a measurement position relative to the imaging optics of the camera.

3. The gas correlation camera of claim 2 wherein said plate is a disc rotatable about a pivot.

4. The gas correlation camera of claim 3 wherein said cells are arrayed in a regularly spaced angular alignment with each of said cells approximately equidistant from the center of said plate.

5. The gas correlation camera of claim 4 wherein said plate is positioned in front of said imaging optics of said camera so that said optics are capable of accepting infrared radiation from said at least three cells.

6. The gas correlation camera of claim 4 wherein said plate is positioned in the optical train of said imaging optics of said camera so that said at least three

cells accept light from the front portion of said optical train and pass that light to the rear portion of said optical train.

7. The gas correlation camera of claim 4 wherein all of said at least three cells are circular and separated by absorptive areas.

8. The gas correlation camera of claim 4 wherein all of said at least three cells are trapezoidal and separated by purely absorptive areas, which may range in width from being as narrow as is structurally feasible to being in angular extent to the gas cells.

9. The gas correlation camera of claim 4 wherein all of said at least three cells are triangular and separated by absorptive areas, which may range in width from being as narrow as is structurally feasible to being in angular extent to the gas cells.

10. The gas correlation camera of claim 4 wherein said gases are chosen from the group consisting of N_2O, CO, CO_2, CH_4 and C_3H_8 and a narrow band pass filter as a substitute for the gas O_3.

11. The gas correlation camera of claim 10 wherein at least one of said absorptive cells absorbs infrared radiation in the spectral range of about 2000 cm^{-1} to about 2300 cm^{-1}.

12. The gas correlation camera of claim 10 wherein at least one of said absorptive cells absorbs infrared radiation in the spectral range of about 1300 cm^{-1} to about 1360 cm^{-1}.

13. The gas correlation camera of claim 10 wherein measurements are made using two different absorption bands of CH_4, one at wavelengths shorter than 3 micrometers and one at wavelengths greater than 3 micrometers, thus permitting the use of both solar reflected and terrestrially emitted infrared radiation for remote sensing measurements of CH_4.

14. The gas correlation camera of claim 10 wherein measurements are made using two different absorption bands of CO_2, thus permitting the simultaneous retrieval of atmospheric temperature distributions and CO_2 distributions.

15. A method for measuring the 2-dimensional spatial distribution of a mixture of different atmospheric gases, said method comprising the following steps:

(a) passing infrared radiation from a gas mixture under study through a first gas capable of absorbing, in a characteristic manner, infrared radiation emanating from a corresponding first gas in the atmosphere;

(b) passing infrared radiation from a gas mixture under study through a second gas capable of absorbing, in a characteristic manner, infrared radiation emanating from a second corresponding gas in the atmosphere;

(c) passing infrared radiation from a gas mixture under study through a third null (non-absorbing) chamber;

(d) detecting and analyzing the spectral and energy content of the radiation passed by the first gas using the non-absorbing chamber as a reference;

(e) detecting and analyzing the spectral and energy content of the radiation passed by the second gas using the non-absorbing chamber as a reference; and

(f) performing steps (a)-(e) using an optical imaging system and 2-dimensional infrared array detector so that steps (a)-(e) are performed essentially simultaneously for all image elements without the need for a separate mechanical scanning system.

16. A system for measuring the spatial distribution of atmospheric infrared radiation from multiple view angles (as required for tomographic sounding) with high specificity to the absorption bands of specific atmospheric gases, said system comprising:

    (a) one or more gas correlation cameras, each of said cameras comprising:

        i) at least three gas correlation cells, one of said cells filled with a first gas capable of absorbing infrared radiation at one infrared band, and another of said cells filled with a second gas capable of absorbing infrared radiation at another infrared band, and a third of said cells that does not absorb infrared radiation;

        ii) a camera with imaging optics for determining the spatial distributions of both the spectral and energy content of said first infrared band and the spectral and energy content of said second infrared band and using the third cell as a null (non-absorbing) energy content reference; and

    (b) an aircraft carrying the said one or more gas correlation cameras.

17. The system of claim 16 wherein said gas correlation camera(s) is (are) positioned in said aircraft so as to take multi-angle measurements of infrared radiation passing through the same portion of the atmosphere by making repeated observation passes with different viewing geometries.

18. The system of claim 17 wherein the aircraft is replaced by an aerospace vehicle.

19. The system of claim 18 wherein said aerospace vehicle is an unmanned aerospace vehicle.

20. The system of claim 16 wherein the single aircraft is replaced by a plurality of aircraft so as to take multi-angle measurements of infrared radiation passing through the same portion of the atmosphere with each of the said plurality of aircraft having a different viewing geometry.

21. The system of claim 20 wherein the said plurality of aircraft is replaced by a plurality of aerospace vehicles.

22. The system of claim 21 wherein said aerospace vehicles are unmanned aerospace vehicles.

23. A method for determining the 3-dimensional spatial distribution of atmospheric temperature and various atmospheric trace gases, said method comprising the following steps:

    (a) all steps from claim 15;
    (b) repetition of steps listed in (a) from multiple viewing angles using any of the systems of claims 16-22; and
    (c) application of the optimal analysis equations (listed on page 26) to the infrared radiation fields measured in steps (a) and (b) to perform 3-dimensional tomographic retrievals of atmospheric temperature and various atmospheric trace gases.

24. A gas correlation camera comprising:
    (a) at least two gas correlation cells, one of said cells filled with a first gas capable of absorbing infrared radiation at one infrared band and another of said cells filled with a second first gas capable of absorbing infrared radiation at another infrared band; and
    (b) a camera with imaging optics for determining both the spectral and energy content of said first infrared band and the spectral and energy content of said second infrared band.

25. The gas correlation camera of claim 24 wherein said at least two cells are retained in proximity on a cell retaining plate.

26. The gas correlation camera of claim 25 wherein said plate is linked to a source of motive power that moves said plate so that said at least two cells are moved separately sequentially into a measurement position relative to the imaging optics of the camera.

27. The gas correlation camera of claim 26 wherein a third of said at least two cells does not absorb infrared radiation.

28. The gas correlation camera of claim 27 wherein said plate is a disc rotatable about a pivot.

29. The gas correlation camera of claim 28 wherein said cells are arrayed in a regularly spaced angular alignment with each of said cells approximately equidistant from the center of said plate.

30. The gas correlation camera of claim 29 wherein said plate is positioned in front of said imaging optics of said camera so that said optics are capable of accepting infrared radiation from said at least two cells.

31. The gas correlation camera of claim 29 wherein said plate is positioned in the optical train of said imaging optics of said camera so that said at least two cells accept light from the front portion of said optical train and pass that light to the rear portion of said optical train.

32. The gas correlation camera of claim 29 wherein at least one of said at least two said cells is circular.

33. The gas correlation camera of claim 32 wherein all of said at least two cells is circular.

34. The gas correlation camera of claim 29 wherein at least one of said at least two said cells is trapezoidal.

35. The gas correlation camera of claim 34 wherein all of said at least two cells is trapezoidal.

36. The gas correlation camera of claim 29 wherein at least one of said at least two said cells is triangular.

37. The gas correlation camera of claim 35 wherein all of said at least two cells is triangular.

38. The gas correlation camera of claim 24 wherein said gases are chosen from the group consisting of N_2O, CO, CO_2, O_3., CH_3 and C_2H_6.16. The gas correlation camera of claim 14 wherein said gases are chosen from the group consisting of N_2O, CO, CO_2, CH_3, C_2H_6, and a narrow band pass filter as a substitute for the gas O_3.

39. The gas correlation camera of claim 27 wherein at least one of said absorptive cells absorbs infrared radiation in the frequency range of about 2000 cm^{-1} to about 2300 cm^{-1}.

40. The gas correlation camera of claim 26 wherein at least one of said absorptive cells absorbs infrared radiation in the frequency range of about 1300 cm^{-1} to about 1360 cm^{-1}.

41. A gas correlation camera comprising:

(a) a gas-cell retaining plate fitted with at least two cells of gas capable of absorbing infrared radiation, at least one of said at least two cells being capable of absorbing a different band of infrared radiation than another of said at least two said cells;

(b) said retaining plate being further fitted with a cell incapable of absorbing infrared radiation;

(c) said retaining plate having one or more absorbtive areas between at least two of said at least two cells; and

(d) said retaining plate being positioned in line with the axis of the optical imaging train of an infrared camera, said camera being capable of recording infrared light passed through said at least two cells.

42. The gas correlation camera of claim 41 wherein at least one of said at least two cells is circular.

43. The gas correlation camera of claim 42 wherein all of said at least two cells is circular.

44. The gas correlation camera of claim 41 wherein at least one of said at least two said cells is trapezoidal.

45. The gas correlation camera of claim 44 wherein all of said at least two cells is trapezoidal.

46. The gas correlation camera of claim 41 wherein at least one of said at least two said cells is triangular.

47. The gas correlation camera of claim 46 wherein all of said at least two cells is triangular.

48. The gas correlation camera of claim 41 wherein said gases are chosen from the group consisting of N_2O, CO, CO_2, O_3, CH_3 and C_2H_6.

49. The gas correlation camera of claim 41 wherein said gases are chosen from the group consisting of N_2O, CO, CO_2,CH_3, C_2H_6 and a narrow band pass filter as a substitute for the gas O_3.

50. The gas correlation camera of claim 41 wherein at least one of said absorptive cells absorbs infrared radiation in the frequency range of about 2000 cm^{-1} to about 2300 cm^{-1}.

51. The gas correlation camera of claim 41 wherein at least one of said absorptive cells absorbs infrared radiation in the frequency range of about 1300 cm^{-1} to about 1360 cm^{-1}.

52. The gas correlation camera of claim 51 wherein at least one of said absorptive cells absorbs infrared radiation in the frequency range of about 2000 cm^{-1} to about 2300 cm^{-1}.

53. A method for measuring the properties of a mixture of different atmospheric gases, said method comprising the following steps:

(a) passing infrared radiation from a gas mixture under study through a first gas capable of absorbing, in a characteristic manner, infrared radiation emanating from a corresponding first gas in the atmosphere;

(b) passing infrared radiation from a gas mixture under study through a second gas capable of absorbing, in a characteristic manner, infrared radiation emanating from a second corresponding gas in the atmosphere;

(c) detecting and analyzing the spectral and energy content of the radiation passed by the first gas; and

(d) detecting and analyzing the spectral and energy content of the radiation passed by the second gas.

54. A system for tomographic sounding using infrared radiation, said system comprising:

(a) a plurality of gas correlation cameras, each of said cameras comprising:

i) at least two gas correlation cells, one of said cells filled with a first gas capable of absorbing infrared radiation at one infrared band and another of said cells filled with a second first gas capable of absorbing infrared radiation at another infrared band;

ii) a camera with imaging optics for determining both the spectral and energy content of said first infrared band and the spectral and energy content of said second infrared band; and

(b) a plurality of aerospace vehicles, each carrying one of said plurality of gas correlation cameras.

55. The system of claim 54 wherein at least two of said plurality of gas correlation cameras are positioned in at least two of said plurality of aerospace vehicles so as to take measurements of infrared radiation emanating from the ground.

56. The system of claim 55 wherein said at least two correlation cameras are further positioned to take measurements of infrared radiation emanating at least in part from the same area of ground.

57. The system of claim 54 wherein said aerospace vehicle is an unmanned aerospace vehicle.

58. A system for tomographic sounding using infrared radiation, said system comprising:

(a) a gas correlation camera comprising;

i) at least two gas correlation cells, one of said cells filled with a first gas capable of absorbing infrared radiation at one infrared band and another of said cells filled with a second first gas capable of absorbing infrared radiation at another infrared band;

ii) a camera with imaging optics for determining both the spectral and energy content of said first infrared band and the spectral and energy content of said second infrared band, and

(b) an aerospace vehicle carrying one of said gas correlation cameras.

59. The system of claim 58 wherein said gas correlation camera is positioned in said aerospace vehicle so as to take repeated measurements of infrared radiation emanating from the same area of ground when said aerospace vehicle makes repeated passes over said same area of ground.

60. The system of claim 58 wherein said aerospace vehicle is an unmanned aerospace vehicle.